

Scientists have attempted to construct a global budget to balance estimates of carbon dioxide production and absorption. Until recently it was assumed the land was a net producer of carbon dioxide. Carbon dioxide production in the world exceeds its absorption and there is a global excess of around 5 gigatonnes* of carbon per year. Scientists estimate that carbon dioxide is increasing in the atmosphere at a rate of around 3.4 gigatonnes of carbon per year. Where is the 1.6 gigatonnes of carbon dioxide being absorbed? One hypothesis is that the ocean is absorbing the carbon oxide. Is the ocean capable of absorbing more carbon dioxide? Is the land an important source for carbon dioxide absorption? Two different views are currently being investigated. Pieter Tans at the University of Colorado proposes that a large amount of excess carbon dioxide is being absorbed by terrestrial ecosystems. The more commonly accepted view is that the oceans are probably the carbon dioxide absorber. If an area absorbs carbon dioxide it is called a sink.

**1 gigatonne = 1 Gt = 1,000 million tonnes. 1 tonne = 1000 kilograms*

The oceans capacity to retain carbon dioxide is determined by 3 major factors:

- The chemical properties of carbon dioxide in sea water
- The presence of a "biological pump" that transports carbon dioxide from the surface to the deep ocean
- The circulation of the deep ocean water with water on the surface

Carbon Dioxide and Sea Water

Carbon dioxide has a greater solubility in seawater than do oxygen and nitrogen, the two major components of the air. The amount of carbon dioxide dissolved in seawater rapidly increases up to 1000 meters and then it increases more slowly. This property is due to the biological pump process, discussed in the reading on The Biological Pump. Carbon from the remains of dead algae and other organisms is released in the deeper waters as carbon dioxide. For carbon dioxide to be removed from the atmosphere by the sea, the partial pressure of carbon dioxide in the seawater has to be less than that in the atmosphere. For carbon dioxide

to be drawn down to deeper water the partial pressure of carbon dioxide has to be greater than that in the surface waters. These processes will of course work in the opposite direction dependent upon the relative partial pressure values. The surface water partial pressure of carbon dioxide values determines whether the ocean produces or absorbs carbon dioxide.

The Biological Pump

During photosynthesis marine phytoplankton (algae) absorb light from the sun and combine carbon dioxide, dissolved in the sea, with water to produce carbohydrates: a process, which is called primary production. When primary production is high, many algae are dying per unit volume of seawater, particularly in the surface waters where photosynthesis is greatest. These algae decompose and the particulate matter sinks enriching the deeper waters in carbon dioxide. This process is often termed the biological pump (pumping carbon to the bottom of the sea). One very common example of this is the way carbon dioxide that is dissolved in surface waters is incorporated into microscopic shells or tissues of living organisms and is then carried to the bottom in the remains of the dead organism. This uptake of dissolved carbon dioxide from the surface waters lowers the partial pressure of carbon dioxide. So where the biological pump is active it lowers the partial pressure in deep water not in contact with the atmosphere. In surface waters of low productivity, the partial pressure is often greater than the atmosphere and carbon dioxide is released from the surface.